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Comparison of the effect of Continuous Positive Airway Pressure (CPAP) and Bi-Level Positive Airway Pressure (BiPAP) on hemodynamic parameters in Covid-19 patients: A clinical trial

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Abstract:

BACKGROUND: The most prevalent clinical sign for COVID-19 patients are respiratory diseases such that the criteria for clinical screening and care of the patients in most countries, including Iran, are based on the three primary symptoms, i.e., fever, cough, shortness of breath, or difficulty breathing. The purpose of the current study was to compare the effect of continuous positive airway pressure and bi-level positive airway pressure on hemodynamic parameters in COVID-19 patients.

MATERIALS AND METHODS: It was a clinical trial conducted on 46 COVID-19 patients admitted to Imam Hassan Hospital in Bojnourd in 2022. This study included patients selected through convenient sampling and then through Permuted block randomization, who were assigned to continuous positive airway pressure (CPAP), and Bi-Level Positive Airway Pressure (BiPAP) groups. Patients were compared in terms of the severity of their COVID-19 disease in both groups and were divided equally in each disease severity. After determining their type of respiratory aid use, the patient's hemodynamic status (systolic blood pressure, diastolic blood pressure, pulse, arterial oxygen saturation, and temperature) was examined beforehand, immediately after 1 hour, 6 hours, and then daily up to 3 days of CPAP/BiPAP at a specific time. Data collection tools were demographic data questionnaires and information on patients' diseases. A checklist was also used to record the main variables of the research. The collected data were put into SPSS software version 19. To analyze the data, the Kolmogorov-Smirnov normality test was used to evaluate the normality of quantitative variables. As a result, it was found that the data had a normal distribution. Repeated measures of ANOVA and independent t-tests were employed to compare quantitative variables in the two groups at different times. In this study, a significance level of 0.05 was considered.

RESULTS: There was a significant difference in terms of systolic blood pressure, diastolic blood pressure, respiration rate, pulse rate, oxygen saturation, and temperature in the two groups of patients at 1 day, 2 days, and 3 days after use ($P < 0.05$).

CONCLUSION: The results displayed better performance of CPAP than BiPAP in the parameters of systolic blood pressure, diastolic blood pressure, respiration rate, pulse rate, oxygen saturation, and temperature in COVID-19 patients. Therefore, in necessary cases, it is recommended to use a CPAP mask.

Keywords:

BiPAP, Covid-19, CPAP, hemodynamic, Non-invasive ventilation

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Introdution

COVID-19 is now a global problem, and despite the fact that nearly three years have elapsed since the disease's outbreak, there are still several unsolved issues regarding patient treatment.[1]

With the outbreak of Covid-19 from Wuhan, China in late December 2019 and its rapid global spread, the disease became a global health issue. The rapid and unprecedented spread of this disease caused health and treatment systems around the world to face serious challenges.[2,3] The first cases of this disease in Iran were in February 2019 in Qom and after that, it spread rapidly throughout Iran.[4] The number of people who can be infected by one person in society is an average of 3.5 people, and including this, more than 70% of the society is infected. The fatality rate of this disease in hospitalized patients is 4-11% and the overall fatality rate is 2-3%.[5]

According to the report of the World Health Organization globally, as of 3 February 2023, there have been 754,018,841 confirmed cases of COVID-19, including 6,817,478 deaths, reported to WHO. As of 31 January 2023, a total of 13,168,935,724 vaccine doses have been administered.[6]

The most prevalent clinical sign for COVID-19 patients is respiratory diseases such that the criteria for clinical screening and care of the patients in most countries, including Iran, are based on the three primary symptoms, i.e. fever, cough, and shortness of breath or difficulty breathing.[1] Shortness of breath was recorded in 18.7% of 1099 hospitalized COVID-19-positive patients, and supplemental oxygen was provided to 41% of patients, according to Guan *et al*.[7] Since the body does not acquire sufficient oxygen as a result of shortness of breath, it may develop harmful disorders such as hypoxia.[8,9] The supply of oxygen to the body,[10] which is commonly performed in a variety of methods, is a crucial concern in the treatment of hypoxia. Nasal cannulas, simple facemasks, venturi masks, continuous positive airway pressure (CPAP), and Bi-Level Positive Airway Pressure (BiPAP) are all non-invasive approaches. When there is a significant lack of oxygen in the blood, referred to as hypoxemia (a blood oxygen saturation of less than 90%), oxygen treatment is administered aggressively via intubation.[11] Of all non-invasive methods of respiratory support, continuous positive airway pressure (CPAP), and Bi-Level Positive Airway Pressure (BiPAP) are more typical, both of which enhance oxygen delivery and prevent intubation.[12] Likewise, their major uses include diagnosis of pneumonia and acute respiratory failure, PaO2/FiO2 ratio, i.e. the ratio of arterial oxygen partial pressure (PaO2 in mmHg) to fractional inspired oxygen.[13] Specialist physicians are authorized to utilize either BiPAP or CPAP as patients' needs require. BiPAP is usually employed if CPAP pressure is to be increased to 15-12 mm Hg and respiration by 30 minutes according to the physician's diagnosis and clinical evaluation of the patient.[14] Although CPAP and BiPAP non-invasive ventilation are well endured by most patients, they have their side effects including dry nose, nasal congestion, rhinitis, general discomfort, and claustrophobia. Other side effects caused by such non-invasive ventilation methods are deteriorating lung functioning and affected hemodynamic parameters, which can raise the length of patient hospitalization and treatment costs. The hemodynamic status check contains systolic and diastolic blood pressure, heart rate, and arterial oxygen saturation.[15]

CPAP and BiPAP masks increase intra-thoracic pressure, which in turn decreases venous return to the heart, thereby decreasing cardiac output. In the study of Montner *et al*. on people without previous diseases, it was shown that stroke volume (SV) and cardiac output (CO) decrease.[16] Some studies have shown that the use of a CPAP mask reduces both pulmonary workload and cardiac preload without affecting cardiac index, mean arterial pressure (MAP), and cardiac output.[17] Some other studies showed that CPAP mask reduces cardiac output in patients with chronic heart failure, atrial fibrillation, and blood pressure.[16] However, there are also studies that have rejected the instability of hemodynamic status following the use of breathing aids. Afazel *et al.*'s study in Kashan on CPAP masks[17] and Mohammad Hamid *et al*.'s study in Pakistan on Bi-Pep masks[18] indicated the lack of significant effect of these masks on hemodynamic factors. In addition, most previous studies on the effects of CPAP and BiPAP masks on hemodynamic status have been conducted on patients who are usually in relatively stable conditions and the study comparing these two masks in corona patients was not found.

Although three years have passed since the pandemic of Covid-19, there are still many unknown aspects related to this disease. Apart from the high mortality of this disease, there are several symptoms that even after recovery from the disease in some People have been observed the so-called "long covid syndrome" is called. Covid-19 is not only a respiratory disease but also a thrombotic syndrome with manifestations of different body systems.[19] Some studies have shown that hemodynamic changes occur in Covid-19 patients and these changes can cause cardiovascular complications.[20]

During the period of Covid-19, In addition to community members and women,[21] nurses have suffered many psychological pressures, including stress, anxiety, and depression.[3,4] In such a way that these factors have caused burnout,[2] decreased quality of life[22], and

Post-traumatic Stress Disorder[23] in the nurses. Adopting correct treatment and care measures in dealing with these patients can lead to a better and faster recovery of the patients and cause fewer complications for the patient and prevent re-hospitalization of the patient and subsequently reduce the work pressure of the nurses.

Since the evidence shows that patients with covid-19 suffer from cardiovascular problems and hemodynamic changes, therefore, when necessary, the use of respiratory aids with the least complications is considered. Considering that no study was found comparing the hemodynamic side effects of CPAP and BiPAP masks on patients with Covid-19, Therefore, this study was conducted with the aim of comparing the effect of continuous positive airway pressure and biphasic positive airway pressure on hemodynamic parameters in patients with covid-19. By clarifying the results of this study and choosing the appropriate method of providing oxygen to covid-19 patients with minimal complications, it is possible to help patients recover better.

Materials and Methods

Study design and setting

This was a two-group, clinical trial conducted on COVID-19 hospitalized patients at Imam Hassan Hospital in Bojnourd in 2022.

Study participants and sampling

The study's statistical population contained all COVID-19 hospitalized patients admitted to the hospital who were subject to the use of CPAP or BiPAP. First, the patients were entered into the study based on the goal based on the inclusion criteria and then afterward, by Permuted block randomization they were randomly divided into two CPAP and BiPAP groups.

Data collection tool and technique

After the proposal for this study was approved, permission was obtained from the University Ethics Committee (ethic code committee: IR.GMU.REC.1400.006), and the study was registered at the Clinical Trial Registration Center with the code IRCT20210424051061N1, the researcher went to the hospital, and selected COVID-19 patients according to the doctor's diagnosis and laboratory results. The specialist picked patients in need of non-invasive ventilation in accordance with the protocol of the Office of Respiratory Failure in COVID-19 of the Ministry of Health. Afterward, by Permuted block randomization they were randomly divided into two CPAP and BiPAP groups. The patients were matched according to the severity of the covid disease in both groups and were placed in the group in equal proportion of each disease severity. After determining the type of respiratory ventilation required, the patient's hemodynamic status (i.e., systolic blood pressure, diastolic blood pressure, pulse, and arterial oxygen saturation) was assessed based on the data displayed by the monitor attached to the patient, immediately after use of for one hour, six hours and then checked daily for up to three days at a specific time by the researcher. A total of 46 COVID-19 patients were incorporated into the study. According to the data from a similar study[14] on diastolic blood pressure (SD1 = 3.98, SD2 = 2.75), the research sample size equaled 22 patients using G*Power is a program version 3.1.9.2, members of the F-distribution family test and statistical test ANOVA: repeated measure, between factors based on α =0.05 and 95% test power. Meanwhile, given the 5% probability of attrition, reached about 23 people in each group (46 people in total).

Inclusion criteria included: willingness to participate in the study, age 20-60 years old, no record of cardiovascular disease such as hypertension, need for oxygen, and candidate for Non-invasive ventilation (NIV) according to the physician's analysis (no need for intubation), no prescription of mask use, definitive diagnosis of COVID-19 infection by the physician and laboratory results. Likewise, the exclusion criteria were the need for immediate intubation during the study, level of consciousness based on the Glasgow scale less than 15, and any change in the patient's condition that affected the treatment process, e.g. blood pressure less than 90 mm Hg despite fluid therapy or the use of vasopressors.

Data collection tools were demographic data questionnaire and the information on patients' disease, age, sex, weight, height, BMI, marital status, level of education, socioeconomic status, surgical history, and trauma, underlying diseases, the history of the current disease, the drugs utilized, smoking, and addiction. Furthermore, a checklist was also used to record the main variables of the research including hemodynamic factors (systolic-diastolic blood pressure, pulse rate, arterial oxygen saturation), clinical signs, temperature, respiratory rate, SPO2, FIO2, Pao2, and Paco2. The MK-7000C vital signs monitor was used to measure hemodynamic factors including ECG, NIBP, body temperature (Celsius), SpO2, heart rate (BPM), respiration rate (BPM), and blood pressure (mmHg). Content and face validity were used to determine the validity of the demographic information questionnaire and hemodynamic variables checklist.

In this way, first, based on the existing studies and reliable sources, a questionnaire was compiled and then it was given to 8 members of the nursing faculty and 2 anesthesiologists, and then their opinions were applied. Cronbach's alpha was used to determine the reliability of the instrument, which was 0.88.

In this study, the ResMed created by Philips' recall of Bi-Level Positive Airway Pressure was used. The CPAP works by pressurizing air delivered through a hose and mask to the patient at a certain pressure. The device settings, including parameters like various modes such as S (Spontaneous), T (Time), adjustable pressure range, and initial pressure adjustable by the patient, were adjusted based on the information provided by a physician or specialist. Likewise, as regards continuous positive airway pressure (CPAP) therapy in this research, the CPAP device of Saadat and Venet manufacturers was employed. The CPAP employs an air pump to transfer airflow to the patient at a pressure specified by the mask. The device settings, including adjustable pressure range, 4-20 cm oxygen, pressure adjustment flexibility: 0-3 cm oxygen, initial pressure adjustable by the patient, device settings with button and LED light on the device, storage, calculation, and readability of information Like the average, is the total length of treatment hours, were adjusted based on the information provided by your doctor or specialist.

It should be mentioned that prior to this study, the vital signs monitor, CPAP, and BiPAP were calibrated by the medical equipment unit of the hospital. The collected data were put into SPSS software version 19. After ensuring the data was accurately entered, the mean, standard deviation, and frequency distribution tables were utilized to describe the data. Later, to analyze the data, the Kolmogorov-Smirnov normality test was used to evaluate the normality of quantitative variables. As a result, it was found that the data had a normal distribution. To compare quantitative variables such as blood pressure and pulse in the two groups at different times, repeated measures ANOVA and to compare the variables in the two groups, an independent *t*-test was utilized. Mauchly's test of Sphericity was used to test the assumption of sphericity and homogeneity of covariance, which is a prerequisite for the repeated measures design test. Considering that the assumption of sphericity was not accepted in Mauchly's test ($P < 0.05$), thus Greenhouse-Geisser, Huynh-Feldt, and lower bound statistics were taken into consideration. The significance level was considered at 0.05.

Ethical consideration

Ethical considerations included the following: Obtaining the necessary permission from the university and authorities, introducing the researcher to the research units and explaining how to conduct the research and the purpose of its implementation, completing of the informed consent form to participate in the research by the research units, data collection with the consent and cooperation of the research units, the confidentiality of collected information, compliance with all the ethical codes of the ethical committee.

Results

The majority of research subjects (58.7%) were men. 93.47% of people were married and 69.56% of the research units had no underlying disease. The mean age and standard deviation of the research units in the CPAP and BiPAP groups were 61.57 ± 11.08 and 59.43 ± 12.31, respectively. Likewise, the mean weight of the CPAP and BiPAP groups were 74.57 ± 7.75, and 72.48 ± 10.07, respectively. Based on the results of the independent group's *t*-test, there was no significant difference in terms of age ($P = 0.54$) and weight ($P = 0.43$) between the CPAP and BiPAP groups. The results of the Chi-square test in terms of gender, marital status, education, economic status, underlying disease, and hospitalization history of patients in the CPAP and BiPAP groups indicated that there was no significant difference between the groups ($P > 0.05$). The results of repeated measures ANOVA showed that the mean hemodynamic parameters (systolic blood pressure, diastolic blood pressure, respiration rate, pulse rate, oxygen saturation, and temperature) varied in patients at various hours of using BiPAP [Table 1] and CPAP ($P > 0.05$) [Table 2]. According to the column related to the significance level for all the statistics of the within-group effects test, the null hypothesis is rejected and the influence of the factor variable levels on the dependent variable is well

Table 1: Comparison of the mean of hemodynamic parameters at different time in the BiPAP group

Time	Systolic blood pressure		Diastolic blood pressure		Respiration		Pulse		Oxygen saturation		Temperatures	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Before intervention	129.61	8.92	84.87	7.31	24.22	4.69	101.04	7.58	80.22	5.37	37.40	0.43
5 minutes after use	129.26	7.82	82.65	6.45	23.30	3.43	104.00	7.88	83.26	2.54	37.42	0.45
1 hour after use	128.09	6.79	81.61	6.13	22.57	3.40	101.00	6.41	83.65	3.76	37.20	0.39
6 hours after use	129.43	7.87	83.04	7.10	21.09	2.37	99.26	8.46	84.22	5.68	37.16	0.29
1 day after use	126.96	7.63	80.65	3.12	20.48	2.33	97.13	9.55	85.00	5.51	37.13	0.31
2 days after use	125.78	5.96	80.00	4.45	19.78	2.17	94.13	9.33	85.09	5.17	37.03	0.22
3 days after use	124.04	7.40	79.52	3.01	19.61	2.14	93.04	10.63	87.04	4.00	36.97	0.27
Results of analysis of variance in repeated observations	*F*=5/621, *P*=0/001		*F*=4/495, *P*=0/001		*F*=19/546, *P*=0/001		*F*=15/028, *P*=0/001		*F*=11/876, *P*=0/001		*F*=23/964, *P*=0/001	

defined. Based on the repeated measures ANOVA, the effect was significant five minutes later, 1 hour, 6 hours after use, and 3 days after starting to use CPAP mask in patients; In other words, the difference in the average hemodynamic parameters in patients between five minutes later, 1 hour, 6 hours after use and 3 days after starting to use CPAP mask was significant. The value of the second power of eta shows the extent to which the changes of the dependent variable are explained by the independent variable. The partial value of eta square for the hemodynamic parameters of systolic blood pressure, diastolic blood pressure, breathing rate, pulse rate, oxygen saturation, and temperature are equal to 0.53, 0.30, 0.88, 0.80, 0.89, and 0.74 respectively, which shows that five minutes later, 1 hour, 6 hours after use and 3 days after starting to use CPAP mask, it explains 53.7, 30.9, 88.7, 80.0, 89.7 and 74.5% of the changes respectively in the hemodynamic parameters of systolic blood pressure, diastolic blood pressure, breathing rate, pulse rate, oxygen saturation and temperature in patients [Table 3].

Also about the BiPAP mask, According to the column related to the significance level for all the statistics of the within-group effects test, the null hypothesis is rejected and the influence of the factor variable levels on the dependent variable is well defined. Based on the repeated measures ANOVA, the effect was significant five minutes later, 1 hour, 6 hours after use, and 3 days after starting to use BiPAP mask in patients; In other words, the difference in the average hemodynamic parameters in patients between five minutes later, 1 hour, 6 hours

Table 2: Comparison of the mean of hemodynamic parameters at different times in the CPAP group

Time	Systolic blood pressure		Diastolic blood pressure		Respiration		Pulse		Oxygen saturation		Temperatures	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Before intervention	128.57	9.06	82.65	7.075	25.52	2.466	97.61	6.06	79.83	3.27	37.65	0.51
5 minutes after use	129.57	7.39	83.26	7.39	25.00	3.14	97.91	4.63	81.87	3.18	37.69	0.50
1 hour after use	124.83	7.91	81.04	6.24	20.39	3.66	89.78	5.27	84.96	3.15	37.30	0.43
6 hours after use	123.22	5.16	78.87	3.94	17.83	2.98	83.78	7.55	87.65	2.77	37.03	0.29
1 day after use	121.39	4.45	78.39	4.09	15.39	1.80	80.09	5.55	89.43	2.87	36.84	0.31
2 days after use	118.04	3.94	77.00	5.50	14.04	1.36	77.04	5.87	90.61	2.55	36.69	0.26
3 days after use	115.39	4.72	76.65	4.35	13.17	1.43	75.87	5.81	92.00	2.69	36.57	0.25
Results of analysis of variance in repeated observations	*F*=25/458, *P*=0/001		*F*=9/837, *P*=0/001		*F*=173/205, *P*=0/001		*F*=87/997, *P*=0/001		*F*=191/407, *P*=0/001		*F*=64/293, *P*=0/001	

Table 3: The effects of CPAP mask at different levels on hemodynamic parameters

Partial Eta squared	*P*	*F*	Mean squares	df.	Sum of squares	Epsilon	Parameter
537/0	000/0	485/25	928/622	6	565/3737	Sphricity	Systolic BP
537/0	000/0	485/25	761/1658	253/2	565/3737	Greenhouse-geisser	
537/0	000/0	485/25	304/1481	523/2	565/3737	Huynh- feldt	
537/0	000/0	485/25	565/3737	00/1	565/3737	Lower-bound	
309/0	000/0	837/9	696/161	6	174/970	Sphricity	Diastolic BP
309/0	000/0	837/9	910/425	278/2	174/970	Greenhouse-geisser	
309/0	000/0	837/9	706/379	555/2	174/970	Huynh- feldt	
309/0	005/0	837/9	174/970	00/1	174/970	Lower-bound	
887/0	000/0	205/173	462/586	6	770/3518	Sphricity	Respiratory rate
887/0	000/0	205/173	204/1253	808/2	770/3518	Greenhouse-geisser	
887/0	000/0	205/173	147/1079	261/3	770/3518	Huynh- feldt	
887/0	000/0	205/173	770/3518	00/1	770/3518	Lower-bound	
800/0	000/0	997/87	242/1969	6	453/11815	Sphricity	Pulse rate
800/0	000/0	997/87	326/5161	289/2	453/11815	Greenhouse-geisser	
800/0	000/0	997/87	855/4597	570/2	453/11815	Huynh- feldt	
800/0	000/0	997/87	453/11815	00/1	453/11815	Lower-bound	
897/0	000/0	407/191	445/480	6	671/2882	Sphricity	O_2 saturation
897/0	000/0	407/191	197/905	185/3	671/2882	Greenhouse-geisser	
897/0	000/0	407/191	295/761	787/3	671/2882	Huynh- feldt	
897/0	000/0	407/191	671/2882	00/1	671/2882	Lower-bound	
745/0	000/0	293/64	650/4	6	901/27	Sphricity	Temperature
745/0	000/0	293/64	665/15	781/1	901/27	Greenhouse-geisser	
745/0	000/0	293/64	478/14	927/1	901/27	Huynh- feldt	
745/0	000/0	293/64	901/27	00/1	901/27	Lower-bound	

after use and 3 days after starting to use the BiPAP mask was significant. The value of the second power of eta shows the extent to which the changes of the dependent variable are explained by the independent variable. The partial value of eta square for the hemodynamic parameters of systolic blood pressure, diastolic blood pressure, breathing rate, pulse rate, oxygen saturation and temperature are equal to 0.52, 0.35, 0.40, 0.47, 0.17, and 0.20 respectively, which shows that five minutes later, 1 hour, 6 hours after use and 3 days after starting to use BiPAP mask, it explains 52.1, 35.1, 40.6, 47.0, 17.0 and 20.0% of the changes respectively in the hemodynamic parameters of systolic blood pressure, diastolic blood pressure, breathing rate, pulse rate, oxygen saturation and temperature in patients [Table 4].

The Independent *t*-test was utilized to compare hemodynamic parameters before and after use at specified times in CPAP and BiPAP groups. The results indicated that the mean hemodynamic parameters of systolic blood pressure, diastolic blood pressure, respiration rate, pulse rate, oxygen saturation, and temperature were different in the two groups in patients five minutes, one hour, six hours after using up to 3 days after the use of BiPAP and CPAP. Therefore, 5 minutes after the start of adjuvant pulse ventilation, there was a statistically significant difference between the two groups, yet in the CPAP group, the pulse was lower and closer to normal ($P = 0.003$). In addition, 1 hour later, breathing improved, hence the statistically significant difference between the two groups such that in the CPAP group, breathing was lower and approached normal. Moreover, 6 hours after the intervention, all factors in the two groups showed a statistically significant difference except temperature as systolic and diastolic blood pressure, pulse, and respiration in the CPAP group were much lower and closer to normal. Also, arterial oxygen saturation was higher in the CPAP group and closer to the normal value ($P = 0.013$). One to three days after the intervention, all factors were different in the two groups, so in the CPAP group, it was closer to the normal value ($P < 0.05$) [Table 5].

Discussion

The purpose of this study was to compare the effect of continuous positive airway pressure (CPAP) and Bi-Level Positive Airway Pressure (BiPAP) on hemodynamic parameters in patients with Covid-19. The results of this study revealed that in five minutes, 1 hour, and 6 hours after using CPAP for up to 3 days, the difference in the mean hemodynamic parameters in patients is significant. Mukhtar *et al*. (2020) found that the use of non-invasive ventilation possibly led to a high success rate in the treatment and helped prevent invasive ventilation in 77 patients with severe COVID-19 disease.[24] Furthermore, in a double-blind randomized clinical trial (2020) performed to investigate the effect of CPAP on arterial blood gas parameters and pulmonary side effects after open-heart surgery, it was shown that

Table 4: The effects of BiPAP mask at different levels on hemodynamic parameters

Partial Eta squared	*P*	*F*	Mean squares	df.	Sum of squares	Epsilon	Parameter
203/0	000/0	621/5	590/102	6	540/615	Sphricity	Systolic BP
203/0	001/0	621/5	599/192	196/3	540/615	Greenhouse-geisser	
203/0	001/0	621/5	866/161	803/3	540/615	Huynh- feldt	
203/0	027/0	621/5	540/615	00/1	540/615	Lower-bound	
170/0	000/0	495/4	302/82	6	814/493	Sphricity	Diastolic BP
170/0	019/0	495/4	999/259	899/1	814/493	Greenhouse-geisser	
170/0	016/0	495/4	127/238	074/2	814/493	Huynh- feldt	
170/0	046/0	495/4	814/493	00/1	814/493	Lower-bound	
470/0	000/0	546/19	648/74	6	888/447	Sphricity	Respiratory rate
470/0	000/0	546/19	452/283	580/1	888/447	Greenhouse-geisser	
470/0	000/0	546/19	310/266	682/1	888/447	Huynh- feldt	
470/0	000/0	546/19	888/447	00/1	888/447	Lower-bound	
406/0	000/0	028/15	441/361	6	646/2168	Sphricity	Pulse rate
406/0	000/0	028/15	970/1151	883/1	646/2168	Greenhouse-geisser	
406/0	000/0	028/15	391/1056	053/2	646/2168	Huynh- feldt	
406/0	001/0	028/15	646/2168	00/1	646/2168	Lower-bound	
351/0	000/0	876/11	331/101	6	988/607	Sphricity	O_2 saturation
351/0	000/0	876/11	226/213	851/2	988/607	Greenhouse-geisser	
351/0	000/0	876/11	106/183	320/3	988/607	Huynh- feldt	
351/0	002/0	876/11	988/607	00/1	988/607	Lower-bound	
521/0	000/0	964/23	664/0	6	985/3	Sphricity	Temperature
521/0	000/0	964/23	475/2	610/1	985/3	Greenhouse-geisser	
521/0	000/0	964/23	319/2	718/1	985/3	Huynh- feldt	
521/0	000/0	964/23	985/3	00/1	985/3	Lower-bound	

Table 5: Comparison of mean hemodynamic parameters before and after use at specified times in CPAP and BiPAP groups

Time	Hemodynamic parameters	BiPAP		CPAP		*t*	*P*
		Mean	SD	Mean	SD		
Before intervention	Systolic blood pressure	129.61	8.92	128.75	9.06	0.39	0.69
	Diastolic blood pressure	84.87	7.31	82.65	7.07	1.04	0.30
	Respiration	24.22	4.69	25.52	2.46	-1.18	0.24
	Pulse	101.04	7.58	97.61	6.05	1.69	0.09
	Oxygen saturation	80.22	5.37	79.83	3.27	0.29	0.76
	Temperatures	37.40	0.43	37.65	0.51	-1.78	0.08
5 minutes after use	Systolic blood pressure	129.26	7.82	129.57	7.39	-0.13	0.89
	Diastolic blood pressure	82.65	6.45	83.26	7.39	-0.29	0.76
	Respiration	23.30	3.43	25.00	3.14	-1.74	0.08
	Pulse	104.00	7.88	97.91	4.63	3.19	0.00
	Oxygen saturation	83.26	2.54	81.87	3.18	1.63	0.10
	Temperatures	37.42	0.45	37.69	0.50	-1.89	0.06
1 hour after use	Systolic blood pressure	128.09	6.79	124.83	7.91	1.49	0.14
	Diastolic blood pressure	81.61	6.13	81.04	6.24	0.31	0.75
	Respiration	22.57	3.40	20.39	3.66	2.08	0.04
	Pulse	101.00	6.47	89.78	5.27	6.44	0.00
	Oxygen saturation	83.65	3.76	84.96	3.15	-1.27	0.20
	Temperatures	37.20	0.35	37.30	0.43	-0/84	0.40
6 hours after use	Systolic blood pressure	129.43	7.82	123.22	16/5	18/3	0.00
	Diastolic blood pressure	83.04	7.10	78.87	94/3	4/2	0.01
	Respiration	21.09	2.37	17.83	98/2	10/4	0.00
	Pulse	99.26	8.45	83.78	55/7	45/6	0.00
	Oxygen saturation	84.22	5.68	87.65	77/2	60/2-	0.01
	Temperatures	37.16	0.29	37.03	0.291	1.501	0.14
1 day after use	Systolic blood pressure	126.96	7.63	121.39	4.458	2.845	0.00
	Diastolic blood pressure	80.65	3.12	78.93	4.09	2.10	0.04
	Respiration	20.48	2.33	15.39	1.80	8.27	0.00
	Pulse	97.13	9.55	80.09	5.55	39.7	0.00
	Oxygen saturation	85.00	5.51	89.43	2.87	0.413-	0.00
	Temperatures	37.13	0.31	36.84	0.31	3.15	0.00
2 days after use	Systolic blood pressure	125.78	5.96	118.04	3.98	5.18	0.00
	Diastolic blood pressure	80.00	4.45	77.00	5.50	2.03	0.04
	Respiration	19.78	2.17	14.04	1.36	10.72	0.00
	Pulse	94.13	9.33	77.04	5.89	7.42	0.00
	Oxygen saturation	85.09	5.17	90.61	2.55	-4.58	0.00
	Temperatures	37.03	0.22	36.69	0.26	4.76	0.00
3 days after use	Systolic blood pressure	124.04	7.40	115.39	4.72	7.72	0.00
	Diastolic blood pressure	79.52	3.01	76.65	4.35	2.59	0.01
	Respiration	19.61	2.14	13.17	1.43	11.94	0.00
	Pulse	93.04	10.63	75.87	5.81	6.79	0.00
	Oxygen saturation	87.04	4.00	92.00	2.69	-4.92	0.00
	Temperatures	36.97	0.27	36.57	0.25	5.16	0.00

CPAP proved useful, effectively and safely reducing atelectasis and pleural effusion, as well as increasing oxygen delivery and pulmonary ventilation in patients after open-heart surgery.[25]

In the study of Duca *et al*. (2020), the severity of the respiratory failure and the outcome of patients who need respiratory support in the emergency department during the outbreak of SARS-CoV2 in Italy, primary data on the role of CPAP and noninvasive positive pressure ventilation suggest that CPAP/NIPPV can be a valid strategy for the treatment of patients with severe hypoxia who cannot be admitted to the emergency department due to a lack of critical care resources.[26] Bradley also investigated the effect of CPAP on hemodynamic status in his study. The results showed that CPAP can be helpful as an adjunctive treatment in improving the hemodynamic status of patients with CHF.[27] Bento *et al.* and Sajkov *et al.* also confirm the above findings.[28,29]

Practical clinical guidelines recommend non-invasive ventilation as a preventive strategy to avoid intubation in hypoxemia only when performed by experienced teams in patients with COVID-19 without major organ dysfunction.

The results of this study revealed that the effect was significant five minutes, 1 hour, 6 hours, and up to 3 days after starting the use of BiPAP by patients. That is, the difference in the mean of hemodynamic parameters in patients between five minutes, 1 hour, 6 hours, and 3 days after the use of BiPAP is significant. Carpagnano *et al*. (2021) indicated that patients using BiPAP were more likely to be associated with adverse outcomes (shorter stay duration and lower initial PaO2/FiO2 ratio) than those experiencing CPAP.[30] Non-invasive BiPAP ventilation is commonly used in patients with type-2 respiratory failure such as COPD, so it may be useful in patients with both COPD and COVID-19.[31] Also In their study, Moret *et al*. investigated the hemodynamic effects of BIPAP in acute heart failure patients. The results showed that BIPAP significantly improved all hemodynamic factors.[32] In their study, Hamid *et al*. investigated the effects of BiPAP on hemodynamic factors. The results of their study showed that all respiratory factors improved after BiPAP administration, but hemodynamic factors did not show any significant difference. Perhaps the reason for this difference in the results is that they conducted their study on patients undergoing heart surgery.[18]

BiPAP in COVID-19 may help improve respiratory function. Nevertheless, there is a risk that improper adjustments may allow the patient to receive too much airflow and cause Barotrauma.

The results of this study revealed that there was no significant difference in the time before intervention in terms of hemodynamic parameters of systolic blood pressure, diastolic blood pressure, respiration rate, pulse rate, oxygen saturation, and temperature in the two groups of patients using BiPAP and CPAP. At 5 minutes after use, there was no significant difference in terms of systolic blood pressure, diastolic blood pressure, respiration rate, oxygen saturation, and temperature between the two groups of patients using BiPAP and CPAP, while there was a significant difference in the pulse rate between two groups of patients. Álvarez *et al*. (2020) demonstrated that non-invasive ventilation improves hemodynamic status but does not affect cardiac output. In this study, the hemodynamic status was examined two times: before the start of assisted ventilation and 30 minutes after the start.[33]

The results of the present study indicated that 1 hour after use, there was no significant difference in terms of systolic blood pressure, diastolic blood pressure, oxygen saturation, and temperature between the two groups of patients. Yet, in terms of the number of breaths and number of pulses in the two groups of patients, there was a significant difference as in the CPAP group; the number of pulses and respiratory rates was closer to normal. At 6 hours after use, there was a significant difference in terms of systolic blood pressure, diastolic blood pressure, respiration rate, pulse rate, and oxygen saturation in the two groups of patients using BiPAP and CPAP, while there was no significant difference in temperature between the two groups of patients. Hence, increased intrathoracic pressure not only did not cause respiratory failure but also sometimes improved hemodynamics. At 1, 2, and 3 days of BiPAP and CPAP use, a difference was seen between the two groups in terms of systolic blood pressure, diastolic blood pressure, respiration rate, pulse rate, oxygen saturation, and temperature. It showed better performance of CPAP compared to BiPAP in parameters of systolic blood pressure, diastolic blood pressure, respiration rate, pulse rate, oxygen saturation, and temperature of patients with COVID-19. In a recent randomized controlled trial, Patel *et al*. discovered that non-invasive helmet ventilation improved intubation in patients with ARDS compared with non-invasive facial mask ventilation (61 to 18%, respectively) which significantly reduces it.[34] Burns *et al*. (2002) indicate that CPAP or BiPAP therapy can be utilized as a part of a strategy in COVID-19 management hospitals.[35] Non-invasive ventilation, therefore, has the potential to delay or even prevent the need for intubation and make it a regular part of the intensive care unit. It seems that non-invasive CPAP ventilation is acceptable in the inpatient wards of patients with covid-19. Nonetheless, in cases where invasive ventilation is required, non-invasive ventilation is no substitute for it. Not all patients are good candidates for treatment with a non-invasive ventilation tool, and most anxious patients find it difficult to tolerate. Accordingly, a management plan should be prepared according to the appropriateness of invasive ventilation in case of failure of non-invasive ventilation.[36] On the other hand, the use of this ventilation method requires great sensitivity in terms of infection control, the virus spread, and the chances of infection related to these patients, so there are limitations in how to use it. If the treatment team is used, especially nurses, they should be well-trained.[37]

Limitation and recommendation

The limitation of this research was that in this study, hemodynamic factors were investigated in a short period of time and we could not investigate the durability of the changes.

According to the findings of the current research, the following suggestions are presented for future research. Comparison of the effect of continuous and biphasic positive airway pressure on the mortality rate of patients with covid-19 and Comparison of the effect of continuous and biphasic positive airway pressure on hemodynamic parameters in patients with covid-19 at one day until one week after the intervention.

Conclusion

Examination of the findings revealed that the difference in hemodynamic parameters in patients was significant between five minutes, 1 hour, 6 hours after use, and up to 3 days after starting to use CPAP. Furthermore, the effect was significant in patients five minutes, 1 hour, 6 hours after use, and up to 3 days after starting to use BiPAP. This study demonstrated that CPAP and BiPAP therapy could be employed as part of a strategy in COVID-19 management hospitals. Thus, non-invasive ventilation has the potential to delay or even prevent the need for intubation and make it a regular part of the intensive care unit. It seems that non-invasive CPAP and BiPAP ventilation is acceptable in COVID-19 patients' hospitalization units. In acute respiratory failure, CPAP and BiPAP are shown to improve arterial oxygenation. Nonetheless, the results displayed better performance of the CPAP compared to the BiPAP in the parameters of systolic blood pressure, diastolic blood pressure, respiration rate, pulse rate, oxygen saturation, and temperature in COVID-19 patients.

The results of the current research showed the positive effect of both CPAP and BiPAP masks on the recovery process of patients with Covid-19. Although in the first minutes, there was no difference between these two masks in terms of hemodynamic parameters, the results showed better performance of the CPAP mask compared to the BiPAP mask in relation to hemodynamic parameters over time (one and three hours after administration), especially on systolic blood pressure, diastolic blood pressure, breathing rate, pulse rate, oxygen saturation. Therefore, in similar cases where the doctor is allowed to use both masks and there is an indication for both masks, it is recommended to use a CPAP mask.

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Conflicts of interest

There are no conflicts of interest.

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